

Injury and clinical patterns according to age groups in pediatric orbital fractures

Injury and clinical patterns groups in pediatric orbital fractures

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Abstract

Aim: Presentation and clinical patterns of pediatric orbital fractures are different from those of adults. Age is a significant indicator and there is scarce knowledge about the association between pediatric age groups and injury mechanism and clinical patterns of pediatric orbital fractures. We aimed to review the injury and clinical patterns according to age groups in pediatric orbital fractures.

Material and Methods: About 124 pediatric patients with isolated orbital fractures were included in the study. Patients were divided into three age groups such as 0-6, 7-12, and 12-18 age of years. Data included age, sex, injury mechanism, presenting symptoms, fracture site and type, presence of entrapment and computed tomography (CT) findings were reviewed and statistically compared.

Results: Orbital floor fractures were the most common type of orbital fracture. There were significant differences among the age groups in terms of injury mechanism and fracture site ($p<0.001$ and $p<0.0001$ respectively). Nausea and vomiting were the most common presenting symptoms. About 15 tissue entrapments were observed in 11 patients. Fat tissue entrapment was the commonest. The majority (83%) of patients were treated conservatively. Diagnosis of all tissue entrapments was confirmed by CT findings and treated surgically.

Discussion: The clinical examination and CT findings should be correlated for optimal management of the patients with orbital fractures. The correlation of the presenting signs and symptoms with CT findings should be considered for a surgical treatment option.

Conclusion: Orbital floor fracture is the commonest orbital fracture type in pediatrics. Injury mechanisms and fracture sites vary according to age groups. CT findings are necessary for accurate assessment of orbital fractures and early diagnosis of tissue entrapment.

Keywords

Orbital fractures; Age groups; Pediatrics; Tissue entrapment

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Introduction

Orbital fractures comprise about 3%-45% of all facial fractures [1,2]. Low-velocity but high force crush injuries due to falls, motor vehicle and bicycle accidents, and assault are principal injury mechanisms in children with an orbital fracture. The majority of orbital fractures are observed in boys and prevalence increases with aging. Orbital floor fractures are rarely seen in children younger than 5 years due to the completion of maxillary sinus pneumatization occurring after the age of 8 years. Orbital fractures in children may lead to serious complications if not diagnosed and treated timely, and display differences in terms of location, injury mechanism and clinical presentation in children compared to adults [3-7]. The involvement of the roof of the orbit is more frequently seen in younger children with orbital fractures due to the presence of relatively larger cranium. Craniofacial disparity decreases as children grow so lower orbital fractures are more frequently seen in older children [1,5].

Clinical presentation and severity of orbital fractures are widely variable. Despite the rarity, early diagnosis and management of orbital floor fractures are extremely important in the presence of the entrapment of intraorbital tissue. Tissue entrapment in these fractures may lead to hemodynamic instability and unfavorable outcomes. Computed tomography (CT) is the most accurate imaging tool for the detection of soft tissue injuries due to orbital fractures [8,9].

Our study aimed to retrospectively and comprehensively review the injury and clinical patterns according to age groups in pediatrics patients < 18 years of age evaluated using CT.

Material and Methods

Patients

After the current study was approved by our ethics committee, we retrospectively reviewed the medical records of the pediatric patients admitted to our emergency department with the complaints due to orbital fractures between January 2015 and October 2019. Data including age, sex, cause, and type of injury, presenting complaints, and CT findings were examined. Patients were grouped according to age: Group 1, comprised up to 6 years; Group 2 (39%), 7-12 years (17%); and Group 3, 13-18 (44%) years. Details of fractures such as type, location, and extent were noted according to CT reports. CT findings were analyzed to determine evidence of herniation or entrapment in fracture defects. Patients who were not clinically assessed at our emergency clinic within 24 hours after injury and patients with craniofacial fractures were excluded from the study. Patients who transitioned their care to another hospital were also excluded from the study.

CT protocol and measurement

The orbital CT examinations were performed with a CT machine (GE Optima 660 SE 64 Detector 128-slice CT, General Electric Medical Systems, Milwaukee, WI), which included axial, coronal, sagittal images. The data of the patients were provided by the hospital automation system and the picture archiving and communication system (ExtremePacs, Ankara, Turkey). Two experienced radiologists reviewed the CT images.

Statistical Analysis

The statistical analysis of data was carried out using Statistical

Package for the Social Sciences, Version 20.0 (SPSS Inc., Chicago, IL). All quantitative variables were reported as mean/ median and standard deviation. The Kruskal-Wallis test was used for statistical comparisons of the means for more than two groups. Qualitative and categorical variables were recorded as frequencies and proportions. Comparisons of the proportions were done using the Chi-Square test. P<0.05 values were accepted as significant.

Results

A total of 124 pediatric patients with orbital fracture were included in our study. There were 71 (57%) boys and 53 (43%) girls. The mean age at the time of presentation was 11.60±0.43 years (range, 1-18 years). The mean time from injury to admission to the emergency unit was 51.41±1.82 minutes (range, 15-120 minutes). About 68% of patients admitted to the emergency unit within one hour after injury. There was a significant (p<0.001) difference between the age groups in terms of injury mechanisms. Falls were the most common cause of orbital fracture in the group of 1-6 age years whereas hits due to the sport were significantly more common cause in the group of 13-18 age years. Injury mechanisms according to age groups were shown in Table 1.

Table 1. Injury mechanisms of orbital fractures according to age groups

Injury mechanism	Age group (1-6 years) (n=21) (B/G)*	Age group (7-12 years) (n=48) (B/G)*	Age group (13-18 years) (n=55) (B/G)*	B/G (71/53)
Traffic accidents	0	0	10 (8.1%) (10/0)	10 (8.1%) (10/0)
Hits	7 (5.6%) (2/5)	29 (23.4%) (18/11)	31 (25%) (15/16)	67 (54%) (35/32)
Fall	11 (8.9%) (7/4)	4 (3.2%) (4/0)	1 (0.8%) (1/0)	16 (13%) (12/4)
Bicycle accidents	3 (2.4%) (1/2)	14 (11.3%) (7/7)	5 (4%) (1/4)	22 (17.7%) (9/13)
Assault	0	0	5 (4%) (3/2)	5 (4%) (3/2)
Gunshot	0	1 (0.8%) (1/0)	3 (2.4%) (1/2)	4 (3.2%) (2/2)
(B/G)* indicates boy/girl ratio				

There was also a significant difference (p<0.001) between the age groups in terms of the fracture site. All orbital roof fractures were observed in 1-6 age group patients, and the most common fracture site was the orbital floor (49.2%) in all orbital fractures. Combined orbital fractures comprised up to 23.4% of all orbital wall fractures. About 95% of orbital wall fractures in 1-6 age group patients were isolated fractures, whereas only 69% of those in 13-18 age group patients were isolated fractures (p=0.017). Orbital fracture sites according to age groups were detailed in Table 2. A total of 15 (12.1%) tissue entrapments were noted in 11 (8.9%) trapdoor fractures. The most common entrapped tissue was fat tissue (n=6), followed by the inferior rectus muscle (n=5), and medial rectus muscle (n=4) (Figure 1a,b,c) (Figure 2 a,b). The common presenting symptom was nausea and vomiting (82%), followed by ophthalmologic

Table 2. Site of orbital fractures according to age groups

Site of orbital fracture	Age group (1-6 years)	Age group (7-12 years)	Age group (13-18 years)	Total
Roof	8 (6.5%)	0	0	8 (6.5%)
Floor	10 (8.1%)	23 (18.5%)	27 (21.8%)	60 (48.4%)
Medial	3 (2.4%)	15 (12.1%)	22 (17.7%)	40 (32.3%)
Lateral	0	4 (3.2%)	5 (4%)	9 (7.3%)
Combined	1 (0.8%)	11 (8.9%)	17 (13.7%)	29 (23.4%)

complaints (72.5%), headache (43.5%), epistaxis (27%) and loss of consciousness (4%). The most common clinical ocular examination finding was ocular motility restriction which was observed in 72.6% of the patients with orbital fractures, and followed by diplopia in 36% of the patients. The frequency of the ocular findings according to age groups were detailed in Table 3.

Table 3. Frequency of the ocular findings according to age groups

Ocular finding	Age group (1-6 years)	Age group (7-12 years)	Age group (13-18 years)	Total
Ocular motility restriction	14 (11.3%)	41 (33%)	35 (28.2%)	90 (72.6%)
Diplopia	6 (%4.8)	20 (16.1%)	19 (15.3%)	45 (36.3%)
Enophthalmos	1 (0.8%)	10 (8.1%)	29 (23.4%)	30 (24.2%)
Eyelid ecchymosis	10 (8.1%)	12 (9.7%)	7 (5.6%)	29 (23.4%)
Ptosis	-	4 (3.2%)	6 (4.8%)	10 (8.1%)
Trapdoor fracture	-	9 (7.3%)	2 (1.6%)	11 (8.9%)

The majority (83%) of the pediatric patients with orbital fracture were treated by conservatively, and 21 (17%) patients were treated surgically. The most common surgical indication was the muscle entrapment due to orbital floor fractures and noted in 11 patients. The other surgical indications were diplopia (n=7) and enophthalmos (n=3).

Table 4. The distribution of fracture sites according to injury mechanism

Injury mechanism	Orbital roof fractures	Orbital floor fractures	Medial orbital fractures	Lateral orbital fractures	Total
Traffic accidents	0	4 (3.2%)	3 (2.4%)	3 (2.4%)	10 (8.1%)
Hits	2 (1.6%)	40 (32.2%)	20 (16.1%)	5 (4%)	67 (54%)
Fall	6 (4.8%)	7 (5.6%)	3 (2.4%)	0	16 (12.9%)
Bicycle accidents	0	9 (7.3%)	12 (9.7%)	1 (0.8%)	22 (17.7%)
Assault	0	3 (2.4%)	2 (1.6%)	0	5 (4%)
Gunshot	0	4 (3.2%)	0	0	4 (3.2%)
Total	8 (6.5%)	67 (54%)	40 (32.2%)	9 (7.3%)	124 (100%)

Discussion

Pediatric orbital fractures comprise about 40% of all facial fractures [2,10]. The presentation, severity, and management of orbital fractures are widely variable and there is no consensus on their classification and management. Thus pediatric orbital fractures are described as a challenging and controversial clinical problem in the literature [9,11,12]. It has been previously reported that presentation and clinical patterns of pediatric orbital fractures vary significantly with age. The differences in the clinical patterns of orbital fractures result from the growth and development of the craniofacial skeleton [4,7,10,12]. The cranium: face ratio is 8:1 at birth and 2.5:1 in adulthood. Pediatric patients were divided into three age groups: 0-6,7-12 and 13-18 years of age in the literature [1,4,10]. This classification is related to the maturity and growth phases of the facial and orbital skeleton. Facial skeletal growth and paranasal sinus pneumatization occur more rapidly in 0-6 age group children. The highest cranial: facial ratio is in this group [13]. From 7 to 12 years of age is accepted as an average growth phase in terms of growth of the facial and orbital skeleton. Craniofacial anatomy of patients from 13 to18 years of age is more similar to adults [10]. We also grouped our pediatric patients with orbital fracture according to this concept. The incidence and site of orbital fractures in children are also correlated with the development and anatomy of the craniofacial skeleton [14]. Oppenheimer et al. reported that there is a downward shift from cephalic to caudal in facial fracture patterns with age [5]. The orbital floor fractures are relatively rare in children younger than 7 years. The presence of relatively thicker sinus walls, greater bone elasticity, more cheek fat pad, and proportionately smaller and flat midface plays a protective role against blunt trauma. Besides the completion of maxillary sinus pneumatization occurs after the age of 8 years [3,11,15]. The orbital floor fractures were observed slightly more common than orbital roof fractures in this age group of our series. However, there was no significant difference between them. Koltai et al. reported that the probability of lower orbital fractures surpassed the probability of roof fractures in children older than 7 years [16]. As mentioned in the literature, the risk of orbital floor fractures due to blunt facial trauma increases as the face and sinuses develop [3,6,14]. The most frequent fracture location was the orbital floor in all age groups of our study. Orbital roof fractures comprise 1%-9% of all facial fractures. The incidence of orbital roof fractures was reported as 28%-86% in previous studies [16,17]. This ratio was found as 6.5% in our series and all of them were noted in the 0-6 age group of the patients. Higher male preponderance was observed in all age groups. Injury mechanisms causing orbital fractures differ in various parts of the world. The most common cause has been reported as sportive activities in Australia [7], road traffic accidents in India [1] and China [18], activities of daily living in the USA [8]. Variability in orbital fracture patterns has also been reported between rural and urban regions [5]. The majority [73%] of patients admitted to our emergency service were from urban areas. The most common injury mechanism in our patients

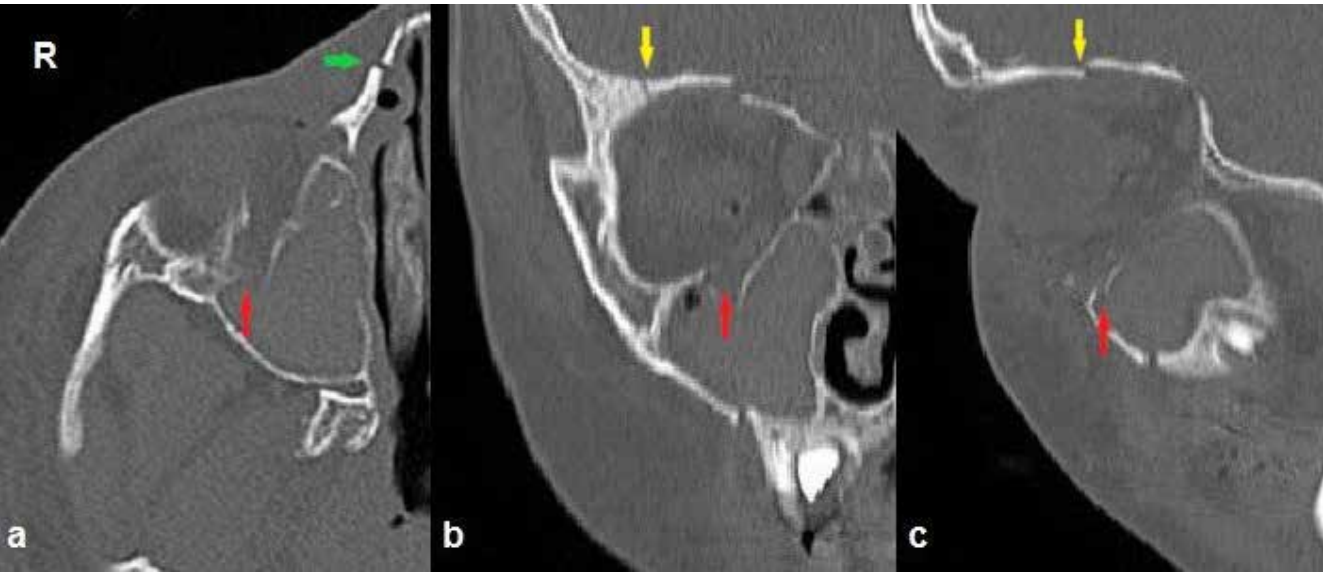


Figure 1. Axial, coronal, sagittal computed tomography images demonstrate a trapdoor fracture in the right orbital floor and herniation of the orbital fat (a,b,c) (red arrows), there is also fractures on the orbital roof (yellow arrows) and nasal bone (green arrow).



Figure 2. The coronal computed tomography image, demonstrates a trapdoor a fracture of the left orbital floor (white arrow). The red arrow points to the inferior rectus muscle herniation into the maxillary sinus through the orbital floor fracture site (a), the coronal computed tomography image, demonstrate a trapdoor fracture of the right medial orbital wall (white arrow), with medial herniation of the medial rectus muscle (red arrow) (b).

were hits and followed by bicycle accidents. Orbital floor fractures are known as blow out fractures and causes of orbital floor fractures in children are clinically described as low-velocity but high force crush injuries due to sports, accidents during play and motor vehicle accidents [3,19]. Distribution of the site of orbital fractures according to injury mechanism was reviewed in our series. Our results showed that hits and bicycle accidents mostly resulted in orbital floor fractures. Orbital roof fractures mostly occurred due to falls [7,14]. Previous studies showed that trapdoor fractures comprise a considerable part (28%-93%) of all pediatric orbital floor fractures. It is well known that children with orbital floor /medial wall fractures carry greater periorbital tissue entrapment risk [1,3,5]. The entrapment of the inferior rectus muscle is a major concern and requires surgical intervention in children with orbital floor fractures [5,7,8,20]. Nausea, vomiting, ocular motility restriction, diplopia, and periorbital soft tissue edema were the most common presenting

signs and symptoms in our series. However it is thought to be that vomiting and nausea complaints were strongly associated with muscle or soft tissue entrapment [1,3], tissue entrapment was diagnosed in a minor part of our patients presenting with nausea and vomiting complaints. Reported the positive predictive value of the presence of nausea and vomiting is estimated as 75% for a trapdoor fracture. This ratio rises to 83.3 in the presence of documented trapdoor fracture [3,8,21]. Firriolo et al. reported that the presence of nausea and/or vomiting to have a sensitivity of 83.3% and similar that of diplopia [8]. The presence of diplopia on forced gaze in the upward vector is described as the distinguishing characteristic of entrapment [5]. Ocular motility restriction and diplopia were common clinical findings in our series as reported in previous studies [1,3,5,18]. Although rare, pediatric orbital fractures with tissue entrapment carry high hemodynamic instability risk and poor long term ocular outcomes. For these reasons, early diagnosis

and management are extremely important. Decreasing the risk of intracranial and ocular complications depends on early diagnosis [5,7,8]. However, the early diagnosis of pediatric orbital fractures may be complicated. The physical examination can not be optimal in severely injured patients. The fundoscopic examination may not be possible in the presence of eyelid with swollen. It is difficult to examine the visual acuity and ocular movement [5, 22].

CT is widely accepted as the imaging gold standard [3.8, 23,24]. Caranci et al. reported that CT is considered the most accurate method in diagnosing orbital fractures. It has been shown that CT is also helpful for detection the periorbital soft tissue injuries [8,9,24]. A good correlation between clinical examination and CT findings is necessary for optimal management of the patients with orbital fractures [3,25]. In our emergency service, physical examination findings of traumatic pediatric patients are supported by CT scan findings for decision making. Surgical indications were based on the correlation of the presenting signs and symptoms with CT findings.

Limitations

The current study was designed as retrospective and reviewed the data obtained from the records in the emergency unit and clinical follow-ups were out of scope.

Conclusions

The presentation and clinical patterns of patients with orbital fractures have a wide spectrum. Clinical characteristics considerably change according to age groups. Hits were found as the most common injury mechanisms for pediatric orbital fractures and attributed to the environmental conditions in rural region pediatric orbital floor fractures comprise the most common type of orbital fractures in our series. There were significant differences among the age groups in terms of injury mechanism and fracture sites. Early diagnosis of the presence of tissue entrapment is a major concern but presenting signs and symptoms may not be helpful for early diagnosis particularly in the 0-6 age group of patients in emergency conditions. CT imaging should be considered for patients with orbital fractures in the presence of the possibility of tissue entrapment.

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Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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